Claims

Claim 1. Apparatus for treating wastewater, wherein:

the apparatus includes a container, having an inlet port for receiving wastewater to be treated and an outlet port;

the container has left and right side-walls and a floor;

the left and right side-walls of the container have respective inwards-facing surfaces, which define a hollow interior of the container, between which the wastewater is contained;

the container includes a treatment-trough, which is of a long/narrow configuration;

the treatment-trough is a component of the container, and is so arranged that wastewater, in passing from the inlet port to the outlet port of the container, passes along and through the treatment-trough;

portions of the left and right side-walls of the container lie in the treatment-trough, and comprise left and right trough-side-walls;

the trough-side-walls confine the water being treated in the treatment-trough, and the apparatus is so configured that water, having once entered the treatment-trough, is constrained, by the trough-side-walls, to pass lengthwise along the treatment-trough, and to remain between the trough-side-walls, to the outlet port;

a portion of the floor of the container lies in the treatment-trough, and comprises the trough-floor;

in a cross-section taken longitudinally along the treatment-trough, being a cross-section taken at the full depth of the trough-floor, a longitudinal-trough-floor-line is the longitudinal line that most closely follows the trough-floor, in that cross-section;

an inlet-point and an outlet-point are points that lie within the container, and are the points on the longitudinal-trough-floor-line, or on extensions of the longitudinal-trough-floor-line, which are closest, respectively, to the inlet port and the outlet port of the container;

the length of the longitudinal-trough-floor-line between the inlet-point and the outlet-point is termed the container-length;

at each point along the container, the container has a respective container-width, being the width between the container-side-walls at that point;

at least some of the points along the length of the container comprise also points-T of the treatment-trough, being those points in respect of which the container-width at the point is less than 1/4 of the container-length;

the treatment-trough comprises the aggregate of all the points-T;

the apparatus includes a body of treatment material, which:-

(a) is porous and permeable to the passage of water therethrough, and is capable of supporting vigorous microbe colonies;

(b) resides in the treatment-trough, and makes tight contact with the trough-floor, and makes tight contact with at least a bottom portion of the trough-side-walls, in such manner as to ensure that water, in passing through the treatment-trough, cannot by-pass the treatment material;

wastewater being treated in the apparatus moves along respective paths, in passing from inlet to outlet, through the body of treatment-material;

in respect of each of the respective paths, the water traverses through, and in contact with, the treatment-material, for respective treatment-lengths, being the longitudinally-projected total length of the contact of the water with the treatment-material;

the shortest one of the treatment-lengths is at least two metres in length, whereby a drop of water, in passing from inlet port to outlet port of the container, traverses a longitudinal distance, in contact with the body of treatment-material, of at least two metres.

Claim 2. Apparatus of claim 1, wherein the floor of the trough is predominantly horizontal;

and in the said cross-section taken longitudinally along the treatment-trough, being a cross-section taken lengthwise at the full depth of the trough-floor, the longitudinal-trough-floor-line, being the line that most closely follows the trough-floor, is horizontal.

Claim 3. Apparatus of claim 1, wherein:

a point along the length of the container comprises a point-T of the treatment-trough only if the container-width at the point, being less than 1/4 of the container-length, also is less than about 100 cm;

the container is characterised in that any and every point along the length of the container in respect of which the container-width at that point is greater than 1/4 of the container-length, is not a point-T of the treatment-trough.

Claim 4. Apparatus of claim 1, wherein:

the said treatment-trough is the only treatment-trough included in the container, in that the container is so arranged that there is no

pathway that wastewater, having entered through the inlet port, could take, which does not pass through the one said treatment-trough;

and the shortest one of the treatment-lengths of the one single treatment-trough is at least three metres.

Claim 5. Container of claim 1, wherein the container includes two or more treatment-troughs, arranged in series, so that the wastewater passes from one to another.

CLAIM 6. Apparatus for treating wastewater, wherein:

the apparatus includes a treatment trough, having an entry port for receiving water to be treated, and an exit port;

the trough has left and right trough-side-walls, and a trough-floor;

the trough-side-walls and trough-floor confine the water being treated, and constrain the water, having been received in the entry port, to pass longitudinally along the trough to the exit port;

the apparatus includes a body of treatment material, which:-

(a) is porous and permeable to the passage of water therethrough, and is capable of supporting vigorous microbe colonies;

(b) fits in the trough, between the left and right trough-side-walls, and rests in contact with the trough-floor;

the structure and arrangement of the apparatus is such that:-

- water undergoing treatment occupies the pores of the treatment material;
- a trough-length of the trough comprises the shortest length of the trough-floor, as measured on a line from the entry port to the exit port, that is both (a) wetted by the water being treated, and (b) in contact with the treatment material;
- at points along the trough-length, the left and right trough-side-walls serves to confine the water undergoing treatment within the treatment-material to respective trough-widths, each respective trough-width being the distance apart of the trough-side-walls at the respective point;
- the trough is of a long/narrow configuration, in that the ratio of the trough-length to the trough-width is 3:1 or more, over at least eighty percent of the trough-length.

Claim 7. Container of claim 6, wherein the structure and arrangement of the apparatus is such that the line, on the trough-floor, comprising the trough-length is at least approximately horizontal over at least eighty percent of its length.

Claim 8. Apparatus of claim 7, wherein:
the trough is long, in that a drop of water, in passing from entry to exit, along the trough-length, traverses a horizontal distance, through the treatment material, of at least two metres; and
the trough is narrow, in that the trough-width is less than about 100 cm, over at least eighty percent of the trough-length; and
the trough is of a long/narrow configuration, in that the ratio of the trough-length to the trough-width is 5:1 or more, over at least eighty percent of the trough-length.

Claim 9. Apparatus of claim 6, wherein the apparatus includes an entry-chamber, which is so arranged that water entering the trough passes first into the entry-chamber before passing into the entry-port of the trough.

Claim 10. Apparatus of claim 6, wherein:
the apparatus includes a plurality of water-treatment sub-troughs, of which the said trough comprises one;
the sub-troughs have respective sub-sides and sub-floors, and respective entry ports and exits ports, and respective sub-trough-lengths, being the respective distances between the entry ports and exit ports;
the apparatus includes a single inlet-pipe, through which all water to be treated by the apparatus is received into the apparatus;
the apparatus includes an entry-chamber, common to all the sub-troughs, which is so arranged that water entering the inlet-pipe passes into and through the entry-chamber before passing into the entry-ports of the sub-troughs;
the sub-troughs are arranged to conduct water away from the common entry-chamber;
the apparatus includes a plurality of sub-bodies of treatment material, disposed respectively one to each sub-trough, of which the said body of treatment material comprises one;
each sub-body of treatment material, in its respective sub-trough:-
(a) is porous and permeable to the passage of water therethrough, and is capable of supporting vigorous microbe colonies;
(b) fits in the sub-trough, between the left and right sub-sides, and rests in contact with the sub-floor;
the structure and arrangement of each sub-trough is such that:-
- a sub-trough-length of the sub-trough is the shortest length of the sub-floor, as measured on a line from the entry port to the exit port, that is both (a) wetted by the water being treated, and (b) in contact with the sub-body of treatment material;

- water undergoing treatment, upon being received at the entry port of the sub-trough, travels longitudinally along the sub-trough to the exit port of the sub-trough;
- at points along the sub-trough-length, the structure of the sub-trough serves to confine the water undergoing treatment to respective sub-trough-widths;
- the sub-trough is of a long/narrow configuration, in that the ratio of the sub-trough-length to the sub-trough-width is 3:1 or more, over at least eighty percent of the sub-trough-length.

Claim 11. Apparatus of claim 10, wherein, in respect of each of the sub-troughs:
the sub-trough is long, in that the sub-trough-length is at least two metres;
the sub-trough is narrow, in that the structure of the sides and floor of the sub-trough is such as to confine the sub-trough-width, to less than about 50 cm, over at least eighty percent of the sub-trough-length.

Claim 12. Apparatus of claim 10, wherein the arrangement of the sub-troughs is such that, between the respective entry and exit ports thereof, there is no communication whereby water could pass between adjacent sub-troughs.

Claim 13. Apparatus of claim 10, wherein the sub-troughs are formed as components of a corrugated sheet of impermeable material, and the corrugations form the sub-troughs.

Claim 14. Apparatus of claim 6, wherein:
the wastewater is water contaminated with carbonaceous BOD, and the arrangement of the apparatus is such:
- that the body of treatment material does not completely fill the treatment trough;
- as to provide an open passage along the length of the treatment material in the trough;
- that the open passage is above the body of treatment material, whereby water cannot enter the passage except on an overflow basis;
- that the air passage is continuous, and runs all along the length of the body of treatment material, and is open to the atmosphere;
- that the water undergoing treatment, residing in the pores of the treatment material, is accessible to air in the passage;

whereby the water in the body of treatment material is exposed to air,

and thereby to the microbiological promotion of aerobic breakdown reactions of the BOD.

Claim 15. Apparatus of claim 6, wherein the apparatus includes structure for maintaining water in the trough at a volume at or above a minimum-volume, whereby the trough, during water treatment, contains never less than the said minimum-volume of water.

Claim 16. Apparatus of claim 15, wherein:
the treatment material is of an absorbent nature, having a capacity for holding water by capillary action;
the body of treatment material is so disposed in the trough that the minimum-volume resides in three water-layers of the body of the treatment material, being:
- a saturated-layer, in which the pores are full of water;
- a wet-layer, in which the pores are more than half full of water;
- and a moist-layer in which the pores contain water but are less than half full;
the trough-floor and trough-sides confine the water-layers to a width overall of less than 100 cm;
the minimum-volume is the aggregate of all water that is present in all three of the water-layers;
the apparatus is so arranged that the body of treatment material also includes a dry-layer, in which the pores contain no water, and which surmounts the moist-layer.

Claim 17. Apparatus of claim 16, wherein the exit-port is at floor level, whereby, but for the absorbency and capillarity of the body of treatment material, the minimum-volume would be zero.

Claim 18. Apparatus of claim 15, wherein:
the exit-port is so structured as to provide a weir, which defines a weir-level, whereby a below-weir level of water upstream of the exit-port, and below the weir-level, is retained in the trough;
the absorbency and capillarity of the body of treatment material provide that an above-weir portion of the saturated-layer resides in the body of treatment material, above the weir-level;
the below-weir portion of the body is included in the saturated-layer;
the remainder of the body of treatment material lies above the weir-level, and includes the wet-layer, the moist-layer, and the dry-layer.

Claim 19. Apparatus of claim 16, wherein the body of treatment material is so dimensioned and configured, in relation to the floor and sides of the trough, that a drop of water, in passing along the shortest pathway a drop of water could take through any of the saturated, wet, and moist layers, permeates through at least two metres of treatment material.

Claim 20. Apparatus of claim 16, wherein the trough-side-walls confine and guide the flow of water along the trough, and are impermeable, and sealed, to the extent that water, once having entered the entry port of the trough, cannot pass outside the trough, except through the exit port thereof.

Claim 21. Apparatus of claim 15, wherein the exit-port is so structured as to provide a weir, which defines a weir-level, and water immediately upstream of the exit-port, and below the weir-level, is retained in the trough;
the weir comprises the structure for maintaining the volume of water in the trough at a volume at or above the minimum-volume.

Claim 22. Apparatus of claim 15, wherein the apparatus includes an operable recirculating-system, which is effective, when operated, to collect water from the exit port, and to transfer the collected water back into the trough, through the entry-port;
and the recirculating-system comprises the structure for maintaining the volume of water in the trough at a volume at or above a minimum-volume.

Claim 23. Apparatus of claim 6, wherein the trough floor is all on one level, and is at least approximately horizontal.

Claim 24. Apparatus of claim 6, wherein the trough floor is on two levels, both of which are approximately horizontal, and which are separated by an intermediate weir.

Claim 25. Apparatus of claim 6, wherein the treatment material is one of:
(a) open-cell foam, having a porosity between ninety and ninety-six percent;
(b) rockwool (tm) spun molten silicate;
(c) sand or gravel having a measurable degree of absorbency;
(d) plastic artificial turf, and the body of treatment material comprises the turf wrapped into a spiral that is a tight fit

inside the pipe.

Claim 26. Apparatus of claim 6, in combination with a source of wastewater to be treated, wherein the source produces water to be treated at the rate of D1 litres per day, and the minimum-volume is at least twenty percent of D1.

Claim 27. Apparatus of claim 6, wherein the treatment trough comprises a treatment-pipe, having a floor, sides, and a roof, of the treatment-pipe, forming a complete circumferential enclosure, and being of constant cross-section along its length.

Claim 28. Apparatus of claim 27, wherein:
the body of treatment material is a resilient body of open-cell foam;
the body of foam is formed with a cross-sectional configuration complementary to that of the pipe, and of such dimensions as to be a tight fit inside the pipe;
except that an upper sector of the body of foam is formed with a cut-out, which comprises the said air-passage.

Claim 29. Apparatus of claim 27, in combination with a source of wastewater to be treated, wherein:
the pipe is right cylindrical, and is not more than 30 cm diameter;
the source produces water to be treated at a rate of T1 litres per day, where T1 is less than 500 litres;
and the length of the pipe, as measured in centimetres, is between ½ and 2 times T1.

Claim 30. Apparatus of claim 27, in combination with a source of wastewater to be treated, wherein:
the pipe is right cylindrical, and is not more than 50 cm diameter;
the source produces water to be treated at a rate of T2 litres per day, where T2 is between 500 and 1000 litres;
the length of the pipe, as measured in centimetres, is between ½ and 1 times T2.

Claim 31. Apparatus of claim 27, in combination with a source of wastewater to be treated, wherein:
the pipe is right cylindrical, and is not more than 100 cm diameter;
the source produces water to be treated at a rate of T3 litres per day, where T3 is between 1000 and 2000 litres;
the length of the pipe, as measured in centimetres, is between ⅛ and ½

times T3.

Claim 32. Apparatus of claim 27, wherein:
the apparatus includes two treatment pipes, arranged in series;
each of the two treatment pipes forms a complete circumferential enclosure and is of constant cross-section along its length.

CLAIM 33. A container for treating wastewater, wherein:
the container includes an inlet port for receiving wastewater to be treated, and an outlet port;
the arrangement of the container is such that, when water enters the inlet port, the level of water in the container tends to rise, thereby causing excess water to flow out from the outlet port;
the container is so arranged that water drains out of the outlet port, down to a minimum-standing-body of water which is retained in the container;
the minimum-standing-body of water has a standing-inlet-point and a standing-outlet-point, which are the closest points on the surface of the minimum-standing-body of water to the inlet port and the outlet port respectively;
the minimum-standing-body of water has a standing-water-length, which is the length of the shortest line through the minimum-standing-body, between the standing-inlet-point and the standing-outlet-point;
the container includes left and right side-walls;
the left and right side-walls have respective inwards-facing surfaces and outwards-facing-surfaces;
the inwards-facing-surfaces define a hollow interior of the container, in which the minimum-standing-body of water is contained, and which are in direct wetted contact with the minimum-standing-body of water;
at each point-P along the standing-water-length of water in the container, the container has a respective standing-water-width-P associated therewith;
the standing-water-width-P is the width overall of the minimum-standing-body of water at the point-P, as measured between the inwards-facing side-surfaces of the left and right side-walls of the container at point-P;
the container includes a treatment-trough, which is of a long/narrow configuration;
the treatment-trough is a component of the container, and is so

arranged that wastewater, in passing from the inlet port to the outlet port of the container, passes along and through the treatment-trough;

each point-P along the standing-water-length comprises also a point-T of the standing-water-length if:-

(a) the standing-water-width-P at that point is less than about 120 cm; and

(b) the standing-water-width-P at that point is less than about 1/4 the standing-water-length;

the treatment-trough comprises the aggregate of all the points-T of the container;

the line of the standing-water-length passes through the treatment-trough, and the treatment-trough has a trough-length, which is the length of that portion of the line of the standing-water-length that lies within the treatment-trough;

the trough-length is at least two metres;

portions of the left and right side-walls of the container that lie in the treatment-trough comprise left and right trough-side-walls, having respective inwards-facing and outwards-facing side surfaces;

the treatment-trough is structurally isolated, in that:-

(a) no portion of the left and right trough-side-walls is wetted on both side-surfaces thereof by the minimum-standing-body of water; and

(b) all points on the outwards-facing side-surfaces of the left and right trough-side-walls lie wholly outside the treatment-trough, in that all the said points on the outwards-facing side-surfaces are not wetted by the minimum-standing-body of water.

Claim 34. Container of claim 33, wherein the minimum-standing-body of water retained in the container has a volume of at least about 1200 litres.

Claim 35. Container of claim 33, wherein the treatment-trough is structurally isolated, in that:-

the trough-side-walls comprise a sheet of impermeable material;

the inwards-facing side-surface and the outwards-facing side-surface comprise opposed surfaces of the sheet of material, and the sheet of material is solid as to its thickness between the two surfaces;

all the points on the inwards-facing side-surface that are wetted by the minimum-standing-body are designated respectively points P1,P2,..,PN;

in respect of all the points P1,P2,..,PN on the inwards-facing side-surface, the sheet of material has a respective thickness T1,T2,..,TN mm;

all the points P1,P2,..,PN on the inwards-facing side-surface correspond to respective points Q1,Q2,..,QN which lie on the outwards-facing side-surface of the trough-side-wall, the points P1,P2,..,PN being spaced respectively T1,T2,..,TN mm from the points Q1,Q2,..,QN;

all points Q1,Q2,..,QN on the outwards-facing side-surface of the trough-side-wall lie wholly outside the treatment-trough, in that all the said points Q1,Q2,..,QN are not wetted by the minimum-standing-body of water in the treatment-trough.

Claim 36. Container of claim 33, wherein the treatment-trough also includes a floor and a roof, which make the treatment-trough circumferentially complete, having respective inwards-facing and outwards-facing surfaces, and all the points on the outwards-facing surfaces of the floor and roof lie wholly outside the treatment-trough, in that all the said points are not wetted by the minimum-standing-body of water in the treatment-trough.

Claim 37. Container of claim 33, wherein the line comprising the standing-surface-length is continuous and uninterrupted, between the standing-inlet-point and the standing-outlet-point.

Claim 38. Container of claim 37, wherein:

the container includes only one treatment-trough, in that the container is so arranged that there is no pathway that wastewater, having entered through the inlet port, could take, which does not pass through the said treatment-trough;

the surface of the minimum-standing-body of water is continuous and all at a single level, between the inlet port and the outlet port;

the trough-length of the one treatment-trough is at least four metres.

Claim 39. Container of claim 33, wherein:

the treatment-trough comprises two series-troughs, arranged in series;

the surface of the minimum-standing-body of water is on two levels respectively in the series-troughs;

and the apparatus includes means for transferring water between the levels.

Claim 40. Container of claim 39, wherein the means for transferring water between the levels is one of (a) a gravity-weir, or (b) an

electric pump, or (c) a siphon.

Claim 41. Container of claim 33, wherein:
the container includes two or more parallel-troughs, of which the said treatment-trough is one;
the container includes an entry-chamber, common to all the parallel-troughs, which is so arranged that water entering the container passes into and through the common entry-chamber before entering the parallel-troughs;
the parallel-troughs are arranged each to conduct water away from the common entry-chamber;
each parallel-trough has a respective parallel-standing-water-length, which is the length of the shortest line through the minimum-standing-body, between the standing-inlet-point and the standing outlet-point, and passing though the water in that parallel-trough;
the parallel-troughs have respective parallel-trough-lengths, being those portions of the respective parallel-standing-water-lengths that lie within the respective parallel-troughs;
the parallel-troughs have respective left and right parallel-trough-side-walls;
in respect of each parallel-trough:-
- the parallel-trough-length is at least two metres;
- at each point along the parallel-trough-length, the parallel-trough has a parallel-trough-width;
- at each point along the parallel-trough-length, the parallel-trough-width is less than 1/4 of the parallel-trough-length;
the arrangement of the container is such that the residence time of water in all the parallel-troughs is substantially the same.

Claim 42. Container of claim 41, wherein the inlet port of the container is common to all the sub-troughs, and comprises the exit-mouth of a single inlet-pipe;
the single inlet-pipe, through which all wastewater enters the container, has a cross-sectional area less than about 180 sq cm.

Claim 43. Container of claim 41, wherein the container includes an exit-chamber, common to all the parallel-troughs, which is so arranged that all water emanating from all the sub-troughs passes into the common exit-chamber, and the outlet port of the container comprises the entry-mouth of a single outlet-pipe.

Claim 44. Container of claim 33, wherein:

the standing-water-length is not more than the trough-length plus three metres; or
the standing-water-length is not more than one-and-a-half times the trough-length-TL.

Claim 45. Container of claim 33, wherein, at each point-T along the trough-length, the minimum-standing-body of water at that point has a respective standing-water-depth-T, which is less than about 1/4 the standing-water-length.

Claim 46. Container of claim 33, wherein each point-P along the standing-water-length comprises also a point-T of the standing-water-length only if the standing-water-width-P at that point is less than about 100 cm.

Claim 47. Container of claim 46, wherein each point-P along the standing-water-length comprises also a point-T of the standing-water-length only if the standing-water-width-P at that point is less than about 70 cm.

Claim 48. Container of claim 33, wherein each point-P along the standing-water-length comprises also a point-T of the standing-water-length only if the standing-water-width-P at that point is less than about 1/6 the standing-water-length.

Claim 49. Container of claim 48, wherein each point-P along the standing-water-length comprises also a point-T of the standing-water-length only if the standing-water-width-P at that point is less than about 1/8 the standing-water-length.

Claim 50. Container of claim 33, wherein, once it has entered the treatment-trough, the water is confined by the trough-side-walls, and continues to the end of the trough.

Claim 51. Container of claim 33, wherein:
the treatment-trough comprises a treatment-pipe, having pipe-side-walls;
the left and right trough-side-walls comprise the pipe-side-walls of the treatment pipe;
the treatment-pipe is circumferentially continuous, and has the same cross-sectional size and configuration, at all points along its length;
the treatment-pipe is structurally isolated, in that:

- no portion of the pipe-side-walls is wetted on both side-surfaces thereof by the minimum-standing-body of water;
- all points on the outwards-facing side-surfaces of the pipe-side-walls lie wholly outside the treatment-pipe, in that all the said points on the outwards-facing side-surfaces are not wetted by the minimum-standing-body of water.

Claim 52. Container of claim 51, wherein the treatment-pipe is right-cylindrical.

Claim 53. Container of claim 51, wherein the inwards-facing surfaces of the pipe-side-walls are smooth and uninterrupted lengthwise of the treatment-trough, whereby substantially no pockets of water can collect, and be retained.

Claim 54. Container of claim 51, wherein:
the container includes an inlet chamber, which contains the inlet-port;
the treatment-pipe is sealingly attached to the inlet chamber, and is in liquid-transfer-communication therewith.

Claim 55. Container of claim 54, wherein the inlet chamber includes a deposition-sump, which is so arranged, as to its depth and location in the inlet chamber, that a portion of the water comprising the minimum-standing-body and residing in the inlet chamber remains still enough to enable sediment present in the water to settle out into the deposition-sump.

Claim 56. Container of claim 51, wherein:
the container includes an outlet chamber, and the outlet chamber contains the outlet-port;
the treatment-pipe is sealingly attached to the outlet-chamber, and is in liquid-transfer-communication therewith.

Claim 57. Container of claim 51, wherein the treatment-troughs comprise two treatment-pipes, and the container includes a middle chamber, sealingly connected between the two treatment-pipes.

Claim 58. Container of claim 33, wherein the treatment-pipe includes a body of a filter medium, which is so structured as to promote the attachment of microbes thereto.

Claim 58. Container of claim 33, wherein:
the wastewater comprises sewage;

the arrangement of the container is such that wastewater entering the minimum-standing-body undergoes anaerobic treatment reactions, and remains in the container long enough that water exiting from the outlet port has undergone substantially complete septic treatment;

the structure of the container is such that the wastewater, in passing from the inlet point to the outlet point, has substantially no opportunity to become aerated;

the arrangement of the container is such that the wastewater remains in the container, on an average flow basis, for at least half a day.

Claim 59. The combination of a container of claim 58 with a dwelling having N bedrooms, wherein the volume of the minimum-standing-body of water retained in the container is N times 500 litres.